GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

# PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. _____

Project No./(Center No.) E-25-603 (R6276-0A0) GTRC/~~GTI~~ DATE 3 / 3 / 87

Project Director: B.H. Tongue School/~~KBB~~ ME

Sponsor: U.S. Army Research Office

Agreement No.: Grant No. DAAL03-87-G-0057

Award Period: From 3/1/87 To 2/28/88 (Performance) 4/30/88 Reports

| Sponsor Amount: | New With This Change | Total to Date |
|---|---|---|
| Contract Value: $ | | $ 82,650 |
| Funded: $ | | $ 82,650 |

Cost Sharing No./(Center No.) _____ Cost Sharing: $ _____

Title: Model Analysis Laboratory

## ADMINISTRATIVE DATA

OCA Contact John B. Schonk ext. 4820

1) Sponsor Technical Contact:

2) Sponsor Issuing Office:

Abram J. Van Hall
U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709

Military Security Classification: _____
(or) Company/Industrial Proprietary: _____

ONR Resident Rep. is ACO: X Yes _____ No
Defense Priority Rating: _____

## RESTRICTIONS

See Attached _____ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT

## COMMENTS:

SPONSOR'S I.D. NO. 02.102.001.86.020

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 4/8/88

Project No. E-25-603-B School/~~XXX~~ ME

Includes Subproject No.(s) N/A

Project Director(s) B. H. Tongue GTRC/~~GIT~~

Sponsor U.S. Army Research Office

Title Model Analysis Laboratory

Effective Completion Date: 2/28/88 (Performance) 4/30/88 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Copy of Last Invoice Serving as Final
- [X] Release and Assignment
- [X] Final Report of Inventions and/or Subcontract:
  Patent and Subcontract Questionnaire sent to Project Director [X]
- [X] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Continues Project No. _____ Continued by Project No. _____

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# FINAL REPORT

# MODAL ANALYSIS LABORATORY

Grant Number: DAAL03-87-G-0057

submitted to

U.S. Army Research Office
Research Triangle Park, NC 27709-2211

submitted by

Benson H. Tongue
Associate Professor
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April 5, 1988

The main item of discussion in this report is the GenRad Computer-Aided Test System 2515, acquired through grant E25-603B. The following is a short account of the uses to which the equipment has been put.

The first task upon receiving the main unit was to determine if the operation was satisfactory. Upon testing, it was determined that the noise levels on several of the channels was too high. Subsequent study indicated a hardware defect which was repaired under warranty. After verification of the unit's abilities in deterministic testing, applications to experimental projects were begun.

The main task to date that the GenRad has been utilized for has been an experimental investigation of chaotic responses in a simple mechanical system. A single degree of freedom device has been constructed to model the dynamics of a periodically forced buckled beam. The actual mechanism is, in fact, a slider-crank mechanism. Thus the results of the experimental study will have a reasonably wide ranging significance, as it will demonstrate that complex nonlinear behavior can occur in fairly common mechanical systems. An analog transducer mounted on a pivot point of the mechanism produces a signal proportional to the angular position of one arm of the linkage. The signal is then passed through an R-C operational amplifier circuit to obtain the differentiated position measurement. This procedure produces real time angular position and angular velocity signals that are ready for data aquisition, the GenRad being utilized for this task. The system is equipped with a CRT screen for numerical and graphical data representation. The system also contains a floppy disk drive for data transfers and a hard disk drive for high-volume data storage.

The GenRad system contains a unique operating system that supports the the TSL-2 user programming language. The use of this language allows the system to sample the position and velocity signal, and assign them to separate data arrays, ready for further signal processing. Software capabilities of the unit are sufficient to allow on-board spectral analysis of the measurements and this capability is exploited in the current project. Internal graphics abilities, coupled with external hard copy devices, permit phase plane and time series representations of the data.

Programs were initially written to obtain time traces of the signals on the CRT screen. At this point, the system was configured to act as an oscilloscope with sampling and data storage capabilities. Based on the encouraging results from initial phases

of the research, the unit was used to investigate Poincaré sections of the nonlinear phase flow and generate spectral decompositions of the motion. The results indicate that subharmonic and chaotic regimes exist for the test device. Work is now ongoing in classifying the different regimes in which particular behavior types occur and in developing a match between the experimental results and numerical simulations.

It is planned that the graduate student currently working on this project, Mr. David Gregorson, will receive his Master's degree by December 1988. The results of his research will be submitted for publication in an appropriate archival journal.

In addition to the above work, research is being initiated that will utilize the GenRad 2515, along with appropriate vibrational transducers, to be used in parameter identification for light weight manipulator dynamics and controls studies. It is anticipated that the GenRad can be used for on-line modal identification.

The final area of current interest is in advanced modal anaysis of structures. A methodology has been developed that allows very accurate analytical estimations of a system's natural frequencies with a very small number of assumed modes. The GenRad will be utilized along with appropriate vibration transducers to provide an experimental match to the analytical estimations, both for beam-like and plate-like structures.